CLAIMS

1. A method of estimating a floor reaction force acting point of a biped walking mobile body for successively estimating the position of the floor reaction force acting
5   point of each leg of a biped walking mobile body, comprising:

a first step for successively grasping the position of the center of gravity of the biped walking mobile body, the position of an ankle joint of each leg, and the
10   position of the metatarsophalangeal joint of the foot of the leg, respectively, and for successively grasping the vertical distance from the ankle joint to a ground contact surface of each leg in contact with the ground while the biped walking mobile body is in a motion, including at
15   least level-ground walking; and

a second step for successively estimating the horizontal position of the floor reaction force acting point of each leg in contact with the ground during the motion on the basis of a relative positional relationship
20   among the position of the center of gravity, the position of the ankle joint, and the position of the metatarsophalangeal joint of the leg that have been grasped in the first step, and also for successively estimating the vertical position of the floor reaction
25   force acting point of the leg as the position vertically apart downward from the ankle joint by the vertical distance from the ankle joint to the ground contact

surface of the leg that has been grasped in the first step.

2. The method of estimating a floor reaction force acting point of a biped walking mobile body according to Claim 1, wherein, when estimating the horizontal position of the floor reaction force acting point in the second step, on each leg in contact with the ground, if the position of the center of gravity is behind the position of the ankle joint of the leg when observed in the advancing direction of the biped walking mobile body, then the horizontal position of the ankle joint of the leg is estimated as the horizontal position of the floor reaction force acting point of the leg, or if the position of the center of gravity is before the position of a metatarsophalangeal joint of the leg when observed in the advancing direction of the biped walking mobile body, then the horizontal position of the metatarsophalangeal joint of the leg is estimated as the horizontal position of the floor reaction force acting point of the leg, or if the position of the center of gravity is between the position of the ankle joint of the leg and the position of the metatarsophalangeal joint when observed in the advancing direction of the biped mobile body, then the horizontal position of the center of gravity is estimated as the horizontal position of the floor reaction force acting point of the leg.

3.   The method of estimating a floor reaction force acting point of a biped walking mobile body according to Claim 1 or 2, wherein the vertical distance from the ankle joint to a ground contact surface of each leg when the

5   biped walking mobile body is in an upright stationary state is measured and retained in a memory beforehand, and when grasping the vertical distance from the ankle joint to the ground contact surface of each leg in contact with the ground in the first step, the vertical distance

10   retained in the memory is grasped as the vertical distance from the ankle joint to the ground contact surface of each leg in contact with the ground.

4.   The method of estimating a floor reaction force

15   acting point of a biped walking mobile body according to Claim 1 or 2, wherein

the vertical distance from the ankle joint to a ground contact surface of each leg and the vertical distance from the metatarsophalangeal joint to the ground

20   contact surface of the leg when the biped walking mobile body is in an upright stationary state are measured and retained in a memory beforehand as a first basic vertical distance and a second basic vertical distance, respectively,

25   and when grasping the vertical distance from the ankle joint to the ground contact surface of each leg in contact with the ground in the first step, if the position

of the center of gravity is behind the position of the

metatarsophalangeal joint of the leg as observed in the

advancing direction of the biped walking mobile body, then

the first basic vertical distance is grasped as the

5   vertical distance from the ankle joint to the ground

contact surface of the leg, or if the position of the

center of gravity is before the position of the

metatarsophalangeal joint of the leg as observed in the

advancing direction of the biped walking mobile body, then

10   the vertical distance between the ankle joint and the

metatarsophalangeal joint of the leg is determined, and

then the value obtained by adding the second basic

vertical distance to the determined vertical distance is

grasped as the vertical distance from the ankle joint to

15   the ground contact surface of the leg.

     5.   The method of estimating a floor reaction force

acting point of a biped walking mobile body according to

Claim 1 or 2, wherein the motion mode of the biped walking

20   mobile body is determined while the processing of the

first step is being executed at the same time when the

biped walking mobile body is in a motion, including at

least level-ground walking of the biped walking mobile

body and walking of the biped walking mobile body on a

25   staircase or a slope, and if the determined motion mode of

the biped walking mobile body is the level-ground walking,

then the position of the floor reaction force acting point

of each leg in contact with the ground is successively estimated by the processing of the second step, or if the determined motion mode of the biped walking mobile body is the walking on a staircase or a slope, then the horizontal

5 position of the metatarsophalangeal joint of each leg in contact with the ground is successively estimated as the horizontal position of the floor reaction force acting point of the leg, and the position vertically apart downward from an ankle joint by the vertical distance from

10 the ankle joint to the ground contact surface of the leg is also successively estimated as the vertical position of the floor reaction force acting point of the leg.

6. The method of estimating a floor reaction force

15 acting point of a biped walking mobile body according to Claim 5, wherein whether the motion mode of the biped walking mobile body is the level-ground walking or the walking on a staircase or a slope is determined on the basis of at least the vertical distance between the ankle

20 joints of both legs of the biped walking mobile body.

7. A method of estimating a joint moment of a biped walking mobile body for estimating a moment acting on at least one joint of each leg of a biped walking mobile body

25 by using an estimated value of the position of a floor reaction force acting point successively determined by the floor reaction force acting point estimating method

according to Claim 1, comprising:

a step for successively estimating the floor reaction force to each leg, which is in contact with the ground, of the biped walking mobile body by using at least a

5 detection output of an acceleration sensor attached to a body of the biped walking mobile body to detect the acceleration of a predetermined part of the body and a detection output of a body inclination sensor attached to the body to detect an inclination angle of the body, and a

10 step for successively grasping the inclination angle of each rigid corresponding part of a biped walking mobile body that corresponds to each rigid body of a rigid link model representing the biped walking mobile body in the form of a link assembly of a plurality of rigid bodies,

15 the acceleration of the center of gravity of the rigid corresponding part, and the angular acceleration of the rigid corresponding part by using at least a detection output of the body inclination sensor and a detection output of an angle sensor attached to a joint of each leg

20 of the biped walking mobile body to detect the bending angle of the joint,

wherein the moment acting on at least one joint of each leg of the biped walking mobile body is estimated on the basis of an inverse dynamics model by using the

25 estimated value of the floor reaction force, the estimated value of the position of the floor reaction force acting point, the inclination angle of the each rigid

corresponding part, the acceleration of the center of gravity of the rigid corresponding part and the angular acceleration of the rigid corresponding part, weight and size of each rigid corresponding part that have been

5 determined in advance, the position of the center of gravity of each rigid corresponding part in the rigid corresponding part that has been determined in advance, and the inertial moment of each rigid corresponding part that has been determined in advance.

10